The value of rearing ponds and a suggestion for their wide spread use.

In 1887 Col. Marshall McDonald, who later became U.S. Commissioner of Fisheries, was superintendent in charge of the Wytheville hatchery in Virginia. Speaking of the hatchery experiments in releasing trout in their fry stage as compared to holding them in retaining ponds until they became fingerlings Col McDonald said;-

"For several years in succession this stream was stocked with the fry of both the California and Eastern brook trout. The aggregate number planted was not much short of 100,000. No appreciable results followed from this work. In August, 1886, about 400 fingerling trout from 4 to 5 inches in length were released into the stream. During the ensuing fall and winter about 100 of these were captured at the head of a little fishway fed by the waste water discharged from the ponds. They had attained a length of 7 to 8 inches, and the brightness and clearness of their colour were in marked contrast to the duller hues of the fish of same age in the ponds. An examination of the stream subsequently showed that the trout were still quite numerous in the stream in the vicinity

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of the hatchery."

"The important lessen to be drawn from these experiments is that in stocking streams infested by small predaceous fish we can only assure success by stocking with trout of sufficient size to dominate the water. Under the circumstances indicated experience shows that several hundred yearling trout are sufficient to stock a stream presenting suitable habitat. On the other hand, we can rarely expect success in stocking such waters with any number of the fry, however great. It may be assumed as a rule that a pair of yearling trout are fully the equivalent of several thousand fry in stocking streams."

In 1899 Mr Cloudsley Rutter made an investigation of the seaward migration of quinnat Salmon fry on the Sacramento river. He followed the young fish down the river and found that upon reaching the salt waters of San Francisco bay they did not at once pass out of the river but remained for days in the brackish water, going forward and backwards with the tide until they accustomed themselves to the brine impregnated waters in which they were to spend the next few years of their lives. As an experiment Mr Rutter transferred some of

the fry direct from fresh to salt water, but found that the sudden transmission was fatal.

It may reasonably be supposed that many fry, whether the result of natural or artificial propagation, would not be able to maintain themselves in brackish water at tidal level, but would be carried by the currents into salt water, and would perish in consequence of the too sudden change. What the percentage of loss from this cause may be we have no present means of knowing, but it is not improbable that, next to the non fertilization of eggs, the loss due to this change from a fresh to a salt water habitat is the heaviest which the young fish are subjected to.

In most fields of scientific research any discovery which gave promise of producing better results than that obtained from past experience, would be further investigated and its value proven. It would appear that the success obtained by Col. McDonald and the discoveries of Mr Rutter should have caused others to take immediate steps to determine by comparison whether retaining the young fish until their fingerling stage was superior to the old method of releasing

them as fry. Especially should we have looked for such action in the artificial propagation of salmon since Col. McDonald's success was with trout, which is a member of the salmon genus. But 33 years have elapsed since Marshall McDonald made public his experience and 21 since Clondsley Rutter's experiments, and still — with few exceptions, and those of recent date — we have persisted in planting salmon in their fry stage. It is no compliment to these two painstaking investigators to speak well of their achievements, while making no effort to profit by their work, and it is all the more to our shame since the old methods we have used, and are still using, have never in any known instance produced one tenth of what Col. McDonald produced 33 years ago.

It is not contended that releasing salmon in their fry stages is without any noticeable results. There can be no doubt but that with some species at least, plantings of fry have produced mature fish. The Sacramento and Columbia rivers demonstrate this, and it might be as well to use these two cases to illustrate what has been done from planting salmon in the fry stage

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compared with what might have resulted had the fish been fingerlings when released.

In its prime the Sacramento, combined with its tributaries, produced, as a whole, 200,000 cases of a salmon pack. After hydraulic mining covered most of the spawning areas below Red Bluff with mud and silt, the McCloud tributary was the one which carried most of the remaining salmon runs. The pack at its lowest ebb was 2281 cases and, since the other spawning beds were mostly eliminated, it is reasonable to assume that these 2281 cases represented the McCloud's quota of the total for the whole river in the years when 200,000 case packs were obtainable.

To-day the take of Sacramento river salmon would, if canned, produce a pack equal to its former greatness, and practically all of this is obtained from the fish which had their origin in the McCloud river sector. Thus it might with reason be claimed that through artificial propagation, and releasing the fish in their fry stage, the annual pack has been built up from 2281 cases to 200,000 cases, or approximately 90 times as much as the McCloud sector originally produced.

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This in itself is an excellent showing, but let us see how it compares to what might have been hoped for from keeping the fish until their fingerling stage and obtaining similar results to what Marshall McDonald obtained.

To fill 700,000 cases, at 70 lbs of fish to the case, and with an average of 22 lbs. weight per fish, would require 636,000 salmon. In some years the hatchery output of fry ran over 100,000,000, and 636,000 — if all were attributed to artificial propagation — would represent a return of roughly but two thirds of one percent. This percentage however is undoubtedly high since there was some natural propagation in those years, to which part of this increase is justly attributable.

Now had these 100,000,000 fish been retained until their fingerling stage before releasing them, and had Col. McDonald's 25% average of mature fish been obtained, the result would have been equal to more than 7,800,000 cases!! In other words the hatchery output of this one river would have produced a return of mature fish equal to the 1919 pack of the entire Pacific Coast!!

The case of the Columbia river can be likened to one's right hand; the whole hand representing the main river; the fingers the upper tributaries such as the Snake, the Spokane, etc * and the thumb the Clackamas. In its prime this combined water shed produced 656,000 cases of canned salmon, of which the Clackamas cannot be credited with over one fifth. To-day the upper tributaries are practically eliminated, owing to dams and irrigation ditches blocking access to the salmon, and it is from the Clackamas that the hatchery supply of eggs is obtained. To-days take of fish is equal to the best years of the past, nearly all of which is attributable to the Clackamas. Thus that tributary shows a five fold increase while the other sections show heavy decreases. Here again salmon released as fry are to be given credit for the result, but as in the Sacramento's case the percentage of return has been less than 1%

The Oregon State hatchery at Bonneville is retaining its salmon in rearing ponds until they attain the fingerling stage. Their success has been proven by the return of marked fish and they estimate the percentage of ~~fingerlings~~ fish released as fingerlings which returned as mature fish to be at

least 5%. This is only one fifth of what Marshall McDonald secured from trout but it is infinitely better than the best known results from fry plantings.

It is not to be expected that (for the present at least) any such quantity as 100,000,000 young salmon can be held in the rearing ponds of a single hatchery for sixteen to eighteen months. But it is a comparatively easy matter to build ponds of sufficient capacity for several million each, and one hundred such rearing ponds scattered along the coast from California to Behring Sea would produce enough fish to double the present annual pack. If such a system was put into effect in 1921 the total Pacific Coast pack of 1925 should be at least double that which can be expected for next season.

All of the foregoing refers to salmon such as the quinnat species whose natural habits cause them to deposit their spawn in streams which flow direct into the sea. How much greater results can therefore be expected from retaining sockeyes in rearing ponds since it is characteristic of them to remain at least one year in fresh water lakes — nature's own retaining ponds. Fry planting is a proven failure with the sockeye species. It has been tried as long, and with less success than the quinnat species, the percentage of return being much under the 2/3rds of 1% which is the maximum credited in the case of the latter fry.

For 35 years planting sockeye fry have produced no appreciable results, but in 1914 Bonneville hatchery released fingerling sockeye which in 1918 returned as mature fish. In 1915 Nanu hatchery in British Columbia planted sockeye fry in natural retaining ponds in the stream which flows into Nanu lake and results attributable to this planting were obtained in 1919. In the same year similar plantings were made in streams flowing into lakes in the lower Fraser watershed, and this work also has proven a pronounced success. All of these undertakings were made independently, and with no knowledge

of what the others were attempting. Except in the case of Bonneville no ~~attempt~~ effort has been made to estimate the percentage of return secured, but this is only practical through a system of marking the fish before releasing them.

One result has been noticed however both with the quinnat and sockeye species. This is an increased weight for the artificially propagated fish as compared to those born under natural conditions. At first blush this does not appear creditable, but a like condition exists amongst wild and domesticated land and air animals, and why not also with fishes? Our domestic cattle through breeding have much surpassed in size their original forbears; the percheron breed of horse is over twice ~~the~~ size of the wild ass or zebra ~~from~~ out of which the race ~~was~~ evolved; and our barnyard fowls are of ~~greater~~ larger ~~stature~~ structure than the jungle fowl of India from which their descent is credited.

~~In~~ The ~~early hatchery~~ operators of the Sacramento river hatchery of early days claimed the average weight of their ~~original~~ quinnat salmon was about 16 lb. The present day average is approximately 22 lb. ~~For~~ A similar increase was noted ~~on~~ the Columbia after hatchery returns appeared, and recently Mr Clanton, the Master Fish Warden, stated still better results were expected from fish held until their fingerling stage. The

average of the past few years has been 22 to 24 lbs for mature fish but those returning this season — thought to be salmon which spent ~~sixteen to~~ eighteen months in rearing ponds — will average 30 lbs. per fish in weight.

Mr Clanton also found the Bonneville Sockeyes, reared until their fingerling stage at that point, averaged considerably heavier than the sockeye salmon of Yes Bay, Alaska, where the eggs had been obtained. Individual fish went as heavy as 13 lbs. while the average was ~~over~~ between 7 and 8 lbs., or nearly 50% heavier than the parent ~~stock~~ stock. This weight question is therefore a very important factor in ~~weighing~~ computing the relative merits of fry vs. fingerling plantings. ~~Since~~

Up to the present hatchery efforts have practically been confined to the quinnat and sockeye species but ~~not only have~~ the cheaper grades have now attained a marketable importance that warrants the employment of artificial propagation with them as well. The need of this is all the greater since they frequent streams which can most easily be fished out, and already the progress toward extermination has advanced so far that no time should be lost in commencing this work.

The study of nature teaches us that once we disturb the natural order of animal life ~~order~~ so as to provide the food requirements of mankind, a decrease in the number

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of the species so attacked is bound to follow unless ~~the~~ either its natural enemies are correspondingly reduced, or man offsets his depredation by supplementing Nature's efforts. In the case of our Pacific salmon the latter ~~course~~ is the only course open to us, ~~and, as previously mentioned, one fatal~~

The streams frequented by salmon are thousands in number and they lie along our coast from California to the Arctic regions. With hardly an exception they are already being exploited by ~~the~~ our fishermen. Each individual stream requires artificial propagation to maintain its runs, and it is manifestly impossible for any government to accomplish this work. The problem confronting us ~~therefore~~ is to find ways and means of doing this ~~ourselves~~ ourselves, and the following is suggested as a feasible method.

Each government interested should for their respective fisheries establish numerous central hatcheries or egg collecting stations in localities easily accessible to those engaged in commercial fishing. These stations should be stocked to their utmost capacity with eggs of all species of salmon and the cost of securing eggs and operating the stations should be computed on the basis of so much per 1000 eggs.

At the close of the fishing ~~operations~~ season it should be compulsory for each operator to furnish the ~~Government~~

authorities with particulars of the number of each species of salmon he had secured that season, and the stream, or streams, the fish were proceeding to when captured. This data would have to show, details of what number of each species was proceeding to each individual stream. From their stations the government should then supply ~~eyed eggs~~ each operator sufficient eyed eggs to offset the number of fish he had secured, and it should be compulsory for said operator to receive such eggs, hatch them properly, and retain them in rearing ponds erected on each of the streams which his commercial operations had depleted. For all eggs so supplied him he should be charged a sufficient sum per 1000 to cover the governments cost in securing and caring for them, and the government should be furnished with the necessary ~~machinery~~ authority to see that the operator conscientiously carried out the share of the work assigned to him.

Let us illustrate this by the following example. John Doe in the course of his fishing operations has secured 10,000 humpback salmon from a certain stream, and so advises the government. The latter estimates that, allowing for natural losses, it will take 200,000 eyed eggs to offset the depletion thus occasioned. Their cost of securing and holding these eggs at the station was $1. per 1000. They would therefore supply John Doe with 200,000 eyed eggs and charge him $200. for same. They would then see that John Doe placed these eggs in gravelled boxes, or other suitable

hatching device, and that he subsequently held the resultant young fish in rearing ponds until they reached the fingerling stage.

By such means the government would ultimately be at no expense for their share of maintaining our salmon fisheries, while the cost to the operators would be small in comparison to the benefits derived, and even his costs might to some extent be offset by reductions in the present tax ~~of so much~~ of 4 cents per case on the canned packs obtained.

There are of course ~~some~~ difficulties to be overcome but these are not insurmountable. For example trap and gill net caught fish cannot always be designated as the run to any particular stream or tributary streams. In such cases a proper division and restocking can only be estimated, at least until investigation shows the approximate percentage of the total each stream should receive under natural conditions if no commercial fishing intercepted the run of fish. Again it would be unfair to compel an operator to assume the cost ~~pay~~ for all the eggs necessary to restock and maintain the streams in his vicinity if some of the fishermen or trap operators were private individuals who sold their catches to outside parties. This difficulty could be overcome by raising the necessary revenue through a tax of so much per fish, such tax to be deducted from ~~paid by~~ the actual fisherman ~~of the~~ by the operator when paying him for his catch. The collection of this could be handled

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in the same manner by which the government now collects the tax on luxuries.

In the case of large rivers on which several fish packing plants are established, it is obvious that individual efforts to maintain rearing ponds would not be feasible. Some modifications of the plan could be devised to achieve the ~~object~~ object aimed at, always bearing in mind that on such rivers each tributary should have its individual rearing ponds in order that the entire watershed shall have its runs maintained as nature intended they should be

If such a system is inaugurated there ~~would~~ must be thousands instead of hundreds of rearing ponds established. The expense would be comparatively small; ~~it~~ it would be ~~shared~~ borne equally by all engaged in the industry; and future generations would have their share of this national asset. The farmer has to pay for the seed from which he attains his crops; the live stock man the feed by which he maintains his herd of cattle. It is not unfair to ask the fisherman to do likewise in his industry, since like the farmer and cattleman he will reap the benefits of the ~~invest-~~ ~~ment~~ expenditure he is called upon to make. It will take from two to four or five years - according to the species - before he can harvest his crop, but if, like the farmer, he can produce many times the best return

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he could expect Nature unassisted to produce, it is surely an investment he is amply warranted in making.